

EXPLORING PRESERVICE TEACHERS' BELIEFS ABOUT THE MATHEMATICS EDUCATION OF ENGLISH LANGUAGE LEARNERS

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This study explores preservice teachers' beliefs about the mathematics education of English language learners. In all, 164 preservice teachers responded to an online survey designed by the researchers. Through the use of descriptive statistics, the data shows that preservice teachers are open to the use of native language; believed that mathematics was devoid of culture; and were more empathetic to the experiences of English language learners if they themselves had experienced trying to learn a second language.

This pilot study sought to expand on research that examined teachers' beliefs regarding the instruction of English Language Learners (ELLs¹) (e.g. Reeves, 2006; Torok & Aguilar, 2000). Our goal was to understand preservice teachers' (PSTs) beliefs about the mathematics education of ELLs; specifically we considered the following research question: What are elementary preservice teachers' beliefs toward (a) the use of language in the school context; (b) the interconnection of language and mathematics; and (c) teaching mathematics to ELLs?

With the increased number of ELLs that are currently mainstreamed into classrooms (Costa, McPhail, Smith, & Brisk, 2005), along with the projected 40% of school students that will speak a language other than English at home by 2030 (AACTE, 2002, as cited in Lucas & Grinberg, 2008), it is vital to prepare teachers to work with this specific population. Within mathematics education, this need is magnified when one considers how ELLs have fared on national high stakes tests. Historically a large percentage of ELLs have performed below the basic² achievement level on the National Assessment of Educational Progress (NAEP) mathematics exam. This trend continued in the latest iteration of the assessment. In 2009, 72% of the eighth-grade ELLs tested were below the basic level compared to just 25% for non-ELLs. At the twelfth-grade, the numbers were 80% and 35% respectively, and at the fourth-grade the numbers were 43% and 16% respectively.

While these percentages indicate that the assessments should be analyzed with a focus on accessibility for ELLs (Kieffer, Lesaux, Rivera, & Francis, 2009), they also support the argument that teachers at all levels need to understand and be willing to incorporate into their teaching practice specific methods of helping ELLs learn mathematics deeply. The National Center for Educational Statistics (2002) reported though that of the 41% of teachers working with ELLs in their classroom, only 13% received adequate preparation. While there are many avenues in which to strengthen this preparation, one important component is for teacher preparation programs to consider the beliefs that PSTs have regarding the mathematics education of ELLs. As Philipp (2007) defined, beliefs can be thought of as "lenses that affect one's view of some aspect of the world or as dispositions toward action" (p. 259). Thus, how a PST views the mathematics education of ELLs will affect how they design and implement mathematical experiences for ELLs in the classroom. By understanding what PSTs believe, teacher preparation programs can design meaningful experiences that will promote a critical analysis of their beliefs.

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Theoretical Perspective

We used an on-line survey to ascertain PSTs' beliefs about the mathematics education of ELLs. While admittedly there are downsides to using surveys (as discussed in Ambrose, Clement, Philipp, & Chauvot, 2004), our reasoning for the use of a survey was two-fold. First, we were concerned that PSTs might answer in a manner they thought was expected of them if we used an interview setting. As Sapsford (1999) noted, "a straightforward question can all too easily evoke a rhetorical or ideological response" (p. 106). We hypothesized that through an anonymous, on-line survey, PSTs would be more honest about their beliefs. Second, a more qualitative approach (such as interviewing or observations) would have been more time-consuming. As such, fewer PSTs would have been able to participate in the study. This was an important consideration since we were interested in understanding the beliefs of a population of PSTs and not just a select few.

The survey instrument was constructed by the researchers due to the lack of appropriate instruments found. At the beginning of another study (Fernandes, Anhalt, & Civil, 2009), which sought to understand how PSTs' beliefs were challenged as a result of conducting two task-based interviews with ELLs and reflecting on the interviews in a structured report, the second author could not find any surveys that would be appropriate to use in the context of mathematics. While survey instruments that focused on teachers' beliefs about working with ELLs or teaching diverse students were found (e.g. Reeves, 2006; Tatto, 1996; Torok & Aguilar, 2000), none focused specifically on the beliefs of PSTs regarding the mathematics education of ELLs. This lack of direct focus was a point of contention for us as the context of mathematics was just as important as the context of working with ELLs. As Cooney, Shealy, and Arvold (1998) noted, beliefs that are central in one domain are not necessarily central in another. Thus we conjectured that framing the statements in the context of the mathematics classroom would encourage the PSTs to consider the nuances of working with ELLs in the domain of mathematics as opposed to in general.

The survey consisted of 14 questions. Each of the statements measured the strength of agreement or disagreement of PSTs' beliefs related to the mathematics education of ELLs with a 5-point Likert-type scale. Each respondent was asked to choose from one of the following choices: Strongly Disagree; Disagree; Undecided; Agree; Strongly Agree. Each of the statements used in the survey was based on research and/or adaptations from items found in other surveys³. Respondents also answered questions relevant to their demographic information such as gender, years of teaching experience, years of experience working with ELLs, spoken languages, and ethnicity.

Methods

We piloted the survey with elementary PSTs from a university in the south east of the country in spring 2010. All of the PSTs were working toward their teaching certification through an accredited teaching certification program and were enrolled in one of the two mathematics methods courses offered that semester. All students enrolled in both methods courses were invited to participate in the study. The second author discussed the study with the two methods teachers and asked each of them to announce the survey to their students. The PSTs were provided a web link that directed them to the survey that was hosted on <http://surveyshare.com>. At the beginning of the survey, individuals were asked to read a consent form detailing the specifics of the study. If the individual indicated consent, they were then provided access to the survey questions. Participants were not asked any identifying information such as name or address. Overall, 164 PSTs participated, a return rate of almost 100%.

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To ensure the validity of the survey, the participants were asked at the end of the survey to answer questions pertaining to the readability and clarity of the survey. In particular, participants were asked the following questions:

1. Were there any ambiguous questions?
2. Was there anything that you did not understand?
3. Was there anything that we did not ask that we should have asked?

Comments from the PSTs about what they did not understand indicated that three were unsure about questions related to their knowledge of teaching and three wanted an option of student teaching/clinical experience to be included in the “Years of experience teaching ELL students.” Related to the former, one respondent commented, “I’m not in the classroom full time, so how am I supposed to know about teaching [ELLs]?” This type of comment was echoed in answers to question 1. Here respondents discussed less the ambiguity of the wording of the questions and more that they were unsure of how to answer the questions based on their experience. All of the PSTs noted that in these cases, they clicked the choice ‘undecided.’ These responses from the PSTs did not reveal any obstacles to their understanding or ability to answer any of the survey items.

The survey results were imported into an MS Excel file that was used to do the analysis. We calculated the percentage of PSTs who agreed with an item by adding the percentage of those who either strongly agreed or agreed with a statement. Similarly, we calculated the percentage of PSTs who disagreed with an item. These percentages are shown in Table 1 for each item. To further understand the alignment of the PSTs’ beliefs with the literature, we obtained a total score for each PST by attaching a numerical value for a response in the Likert-type scale: 1 for strongly disagree; 2 for disagree; 3 for undecided; 4 for agree; and 5 for strongly agree, while reverse coding some items if needed. For us, a score of 1 represented a response that was least aligned with the research literature regarding ELLs and 5 was the most aligned. For example, the statement “Students in the US should be taught in English only” was reverse coded with a PST strongly agreeing scoring 1 and strongly disagreeing scoring 5. Since beliefs can only be inferred, we conjectured that a PST who believed that all students should be taught in English only would be less open to the use of native language as a resource in the classroom. Items 1, 2, 5, 6, 7, 8, and 12 from Table 1 were reverse coded. In this survey, a PST could have obtained a minimum of 14 and a maximum of 70. Our next step was to order the scores and use quartiles to partition the 164 students into four groups, where G1 represented the lowest quartile and G4 represented the highest. Finally we compared the means of the scores from the PSTs in the upper quartile (G1) to those in the lower quartile (G4).

Results

We examined the results of the survey descriptively as we sought to answer our research questions and interpret the results in light of the existing literature. First we report on the demographic information collected about the participants to contextualize the population who responded to the survey. We then report on the percentages of participants that agreed, were undecided or disagreed with the individual statements by considering three main categories of belief statements related to our research questions: (a) beliefs about language in the school context; (b) beliefs about the interconnection of language and mathematics; and (c) beliefs about teaching mathematics to ELLs. These percentages are summarized in Table 1. Finally we report the findings from the comparison of different groups based on the quartile calculations.

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Demographic Information

Of the 164 participants, 153 were female and 11 were male. Of the choices ‘European American,’ ‘African American,’ ‘Hispanic,’ ‘Asian,’ or ‘Other,’ 85% of the PSTs reported being European American/Caucasian/White. (Note that some PSTs chose the ‘other’ category and filled in Caucasian or White.) Of the other 15% of respondents, 7.32% self-reported as African American, 1.22% as Hispanic and 3.05% as Asian. Most of the PSTs either indicated no formal teaching experience or reported classroom observations and clinical teaching required in coursework as their only teaching experience. Finally, over 85% had limited to no experience to working with ELLs prior to the study.

Belief	% Agree	% Undecided	% Disagree
Language in the School Context			
1. Students in the US should be taught in English only.	21.37	13.4	65.2
2. It is more important for immigrants to learn English than to maintain their native language.	41.4	19.5	39
3. In a mathematics classroom, ELLs should be allowed to discuss course material with each other in their native language.	76.83	12.8	10.37
4. ELLs should be assessed in their native language on the State tests.	35.98	37.80	26.22
Interconnection of Language and Mathematics			
5. Mathematics uses symbols and ideas that are not associated with any language or culture.	52.44	23.17	24.39
6. Mathematics is an ideal subject for transitioning recent immigrant students into English.	55.49	33.54	10.98
7. If ELLs can hold a conversation in English, they should have no more of a problem, than non-ELLs, learning mathematics in an English only classroom.	29.88	21.34	48.78
8. Mathematics is not language intensive.	25	15.85	59.15
Teaching Mathematics to ELLs			
9. Whenever possible, ELLs should receive instruction in their native language until they are proficient enough to learn via English instruction.	67.07	15.24	17.68
10. When working with ELLs in a mainstream classroom, teacher lesson plans should incorporate content objects as well as language objectives.	69.52	33.54	5.49
11. Teacher should incorporate explicit language learning strategies in the mathematics lesson if they have ELLs in the class.	66.47	25	8.54
12. Teachers should use the same standards in evaluating the work of all students in the class.	48.18	18.29	33.54
13. It is important to incorporate aspects of the students’ culture into mathematics teaching.	84.15	9.15	6.71
14. Culture plays a significant role in the learning and teaching of mathematics.	56.1	28.05	15.85

Table 1. PSTs’ beliefs about the mathematics education of ELLs

Beliefs about Language in the School Context

A majority of the PSTs (65.2%) disagreed or strongly disagreed with the statement “Students in the US should be taught in English only.” Moreover, 76.83% agreed or strongly agreed with

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allowing ELLs to use their native language when discussing mathematics content in the classroom. Given that most of the PSTs surveyed were monolingual in English (83%⁴), these results point to the PSTs being open to languages other than English being used in the mathematics classroom. However, even though PSTs seemed open to the use of native language for teaching and small group discussions in the class, they seem split on the importance ELLs should give towards learning English rather than maintaining their native language. Namely, 41.4% of the respondents agreed that it is more important for ELLs to learn English while 39% felt that learning English should not come at the expense of the ELL's native language. This agrees with the literature (e.g. Walker, Shafer, & Iiams, 2004; Reeves, 2006) where teachers may assume that the use of native language may interfere with ELLs learning English and thus, more importance should be given to learning English. Finally, the PSTs were about evenly divided when asked about the use of native language on exams, with 35.98% agreeing, 26.22% disagreeing, and 37.8% undecided when responding to the statement "ELLs should be assessed in their native language on the State tests." There are a number of possibilities for the large percentage of students who are undecided. For example, it is possible that PSTs had difficulty deciding between whether it was a beginning ELL or a more advanced ELL that was allowed to take the tests in their native language.

Beliefs about the Interconnection of Language and Mathematics

A little more than half (52.44%) of the PSTs agreed with the statement, "Mathematics uses symbols and ideas that are not associated with any language or culture," with 23.17% being undecided and 24.39% disagreeing. This is in line with beliefs about mathematics being a universal language that is structured and the same for everyone regardless of country or region (Kloosterman, 1999). Indeed, both authors have regularly had informal interactions with PSTs who claim that " $2+2=4$ " is true in any language or culture. This view of universality may account for why a majority of PSTs (55.49%) agreed that mathematics would be ideal to transition recent immigrant students into English. About a third (33.54%) of the PSTs, however, were undecided. It is possible that the PSTs that comprised this percentage see mathematics as inherently difficult and challenging and thus felt that mathematics would not be ideal for any student, regardless of language ability. When asked to consider if ELLs who could hold a conversation in English would have no more of a problem than non-ELLs learning mathematics in an English only classroom, a little less than half of the PSTs (48.78%) disagreed. Moreover, almost 60% of the PSTs disagreed with the statement "Mathematics is not language intensive."

Beliefs about Teaching Mathematics to ELLs

More than two-thirds of the PSTs agreed that ELLs should receive instruction in their native language until they are proficient enough to learn via English. This view is in-line with research (e.g. Moschkovich, 2000) that suggests that educators should draw upon resources ELLs bring with them, such as their native language. Just about or above two-thirds of the PSTs also agreed that teachers should focus on language when working with ELLs be it through focusing on objectives related to language or enacting explicit language learning strategies. Of the PSTs that did not agree with these ideas, a majority (85.9% for objectives and 74.5% for enacting) were undecided suggesting perhaps that the PSTs might be unsure of how or why a mathematics teacher should focus on language. Less than half of the PSTs (48.18%) believed that teachers should use the same standards in evaluating the work of all students, with about a third disagreeing and 18.29% undecided. This distribution points to the fact that while PSTs want to be fair in assessing what their students know and can do, a majority at least question how that

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fairness should play out in the classroom. In regards to how culture should impact the teaching of mathematics, a large number (84.15%) of PSTs felt that it is important to incorporate aspects of the students' culture into mathematics teaching. While we cannot know for certain from this statement alone, it seems that PSTs did not consider the depth to which a student's culture should be incorporated. Instead, they may have felt that, for example, using a context with which an ELL may be familiar in a story problem constitutes incorporating a student's culture. Indeed, when asked if culture should play a *significant* role in the learning and teaching of mathematics, the percentage of respondents who agreed dropped to 56.1, a 33% decrease.

Comparison of Groups

The total scores of the PSTs were divided into quartiles, with Min=33, Quartile 1= 51, Median=55, Quartile 3=58, and Max=62. A box-plot of the scores is shown in Figure 1. Comparing PSTs in G1 (or the scores in upper quartile) to PSTs in G4 (or the scores from the lower quartile), we found the biggest differences in the means of items 1 (G1=3.93, G4=2.71), 7 (G1=3.66, G4=2.49) and 2 (G1=3.32, G4=2.27). This indicates that PSTs in G4 tended to put more emphasis on English only education and were also more likely to mistake conversational proficiency for academic language fluency than PSTs in G1. Items 6 (G1=2.63, G4=2.37), 9 (G1=3.78, G4=3.22) and 5 (G1=2.95, G4=2.32) had the smallest differences of means between G1 and G4. The means in item 6 and 5 were closer to 1 indicating that the PSTs may have felt that mathematics is a difficult subject for all students, independent of language and culture. Item 9 showed that PSTs from G1 and G4 believed that ELLs should receive mathematics instruction in their native language until they are proficient enough to learn via English instruction. Given the beliefs of PSTs from G1 towards language (as seen in items 1, 7 and 2), it is possible that these PSTs view the teaching of ELLs as the exclusive responsibility of the ESL teachers in the school and may be less open to making accommodations in their own classrooms. Demographically, PSTs from G1 and G4 were similar in terms of gender, ethnicity, and previous experience with ELLs, however, the two groups differed in their exposure to a second language. There were 18 PSTs in G1 that spoke English only, compared to 28 in G4; and 23 that spoke an additional language at varying levels of fluency in G1, compared to 13 in G4. Considering this difference, the alignment of the PSTs' beliefs seen in items 1, 7, and 2 to the research could be attributed to their experience in learning a second language.

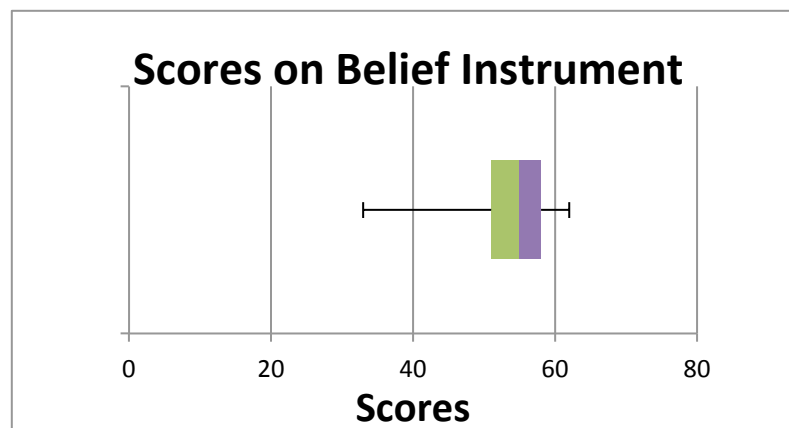


Figure 1. PSTs' overall scores on belief survey

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Discussion

The calculation of percentages of PSTs who agreed or disagreed with a particular statement revealed some interesting connections among the PSTs' beliefs. One in particular concerns how PSTs may see culture within mathematics and mathematics teaching. An overwhelming 84% of PSTs agreed that a student's culture should be incorporated into mathematics teaching, with about 56% stating that culture should play a significant role in the teaching of mathematics. However, about 75% of the PSTs either agreed or were undecided that the symbols and ideas used in mathematics are not associated with any language or culture. These numbers indicate a possible disconnect for PSTs in the teaching of mathematics. One strategy for teaching ELLs suggested from research (e.g. Short & Echevarria, 2004) is to contextualize mathematics through the use of realia and the culture of ELLs in meaningful ways. The possible belief structure of the PSTs based on the percentage calculations suggests that even though PSTs may agree with the strategy suggested in the research, they may not understand how it is feasible to do so in the area of mathematics given that mathematics itself is devoid of context. If this is indeed the case, it sheds light on why teachers (both at the preservice and inservice levels) incorporate culture sometimes in seemingly superficial ways (e.g. changing the names of a story problem).

Finally, as seen in the comparison of groups, the PSTs who had beliefs that fell in the upper quartile (meaning that these PSTs had beliefs which were most consistent with findings from research) reported more experiences learning a language other than English than those PSTs who fell into the lowest quartile. It seems then that by experiencing the learning of another language, PSTs may have empathy for the experience that ELLs go through on a daily basis. However, this empathy may not translate into their teaching practice, as it is possible that they do not see it as their role as a classroom teacher to provide ELLs the type of support called for in research. If this empathy is cultivated, challenged, and nurtured though, PSTs that display the beliefs seen in this survey may develop the habit of mind and teaching practices that are consistent with best practices for teaching ELLs.

Closing Thoughts

While we acknowledge that beliefs are not static and in fact are affected by many factors at any given point in time, it is important that teacher preparation programs take into account what a PST is thinking regarding the mathematics education of ELLs. As can be seen through the findings and discussion from this pilot study, the use of a survey can provide a window into how PSTs may view the inclusion of language in the school context, the interconnection of language and mathematics and the teaching of ELLs. Mathematics teacher educators can use the valuable insight gained from the survey to design meaningful, relevant, and engaging experiences that challenge and confront PSTs' beliefs in an intellectual and respectful manner.

Endnotes

1. We consider English Language Learners (ELLs) as those students who are still developing a proficiency in English and consist of students who speak a language other than English at home.
2. The basic level is the lowest of the three levels a student can obtain on a NAEP assessment and is defined as "mastery of prerequisite knowledge and skills that are fundamental for proficient work" (NCES, 2009).
3. Proper credit was given in all cases where items from other surveys were adapted.

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4. This percentage includes those respondents who either reported 'English' or 'English' plus an elementary/limited/brief amount of a different language when asked, "What languages can you speak? Please explain."

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